EXTRUDED SCINTILLATOR FOR THE MINERνA EXPERIMENT

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SUMMARY

The MINERνA experiment has Stage-1 approval for construction at the Fermilab site. Its main goal is to carry out high-statistics neutrino scattering studies with a fine-grained detector using the NuMI beam line [1]. Its Active Target and Calorimeters will use extruded scintillator. The FNAL-NICADD Extrusion Facility at Fermilab will prepare this scintillator [2]. The extruded scintillator for the Active Target will have a triangular shape, with approximately a base of 31 mm and a height of 17 mm. The strip contains a hole centered along the vertical axis where a 1.2-mm diameter wavelength shifting (WLS) fiber will be inserted. The diameter of the hole is specified at 1.5 ± 0.1 mm. The strips will be assembled into planes.

As part of the R&D for the MINERνA experiment, various extrusion runs have been carried out to prepare the triangular scintillator strips. These strips were used in several studies such as attenuation length measurements of the scintillator using a radioactive source and light yield determinations of the scintillator/WLS fiber system using cosmic rays. Of particular interest are the results gathered from light yield measurements of scintillator strips with a WLS fiber inserted in the hole, where the hole size varied from a close fit to the fiber to a very loose fit (Fig. 1). It is important to determine whether there is an optimum hole size and the allowable variations since tight specifications impact the production cost. Regardless of the hole size, we inserted the same 1.2-mm WLS fiber and measured the resultant light yield. A total of 25 strips were measured. The "Far Light Yield" and the "Near Light Yield" refer to the points measured farthest from and nearest to the PMT respectively. "Average Light Yield" is the mean of four data points along the 1-m scintillator strip. The data plotted in Figure 2 shows that there are only small variations in light yield throughout the strips measured. The spread of the measurements is approximately 5 %. A better match between hole and fiber diameter (0.75-0.9 ratios) does not render a higher light yield. A large mismatch between hole and fiber diameter represented in the lower-ratio range results in light yields that are similar to the rest of the data. The hole size does not have a significant effect in the light yield. The next study checked for differences and improvements if the fiber were glued in the hole. After comparing the fibers, they were inserted into a designated scintillator strip. Each strip was selected to cover a wide range of hole sizes. The approximate fiber to hole ratios were: 0.9, 0.9, 0.4, 0.3, 0.3, and 0.3. After normalizing the strips to the calibrated fiber data (as to ignore the effects of separate fibers), a set of measurements was performed without glue and then the holes were filled with BC600 glue. Each fiber was kept in the same scintillator strip to avoid any inconsistencies. The light yields of the scintillator strips with the glued fiber were approximately 1.9-2.0 times higher (Fig. 3) that those without glue. The light yield increases when the fiber is glued in the hole, but again there is no significant effect if the match between the size of the hole and the fiber is good or bad.

This paper will describe in detail the measurements performed to characterize the scintillator for MINERνA (including spectroscopy, attenuation length and light yield) and the potential impact of these results in the future productions of extruded scintillator.

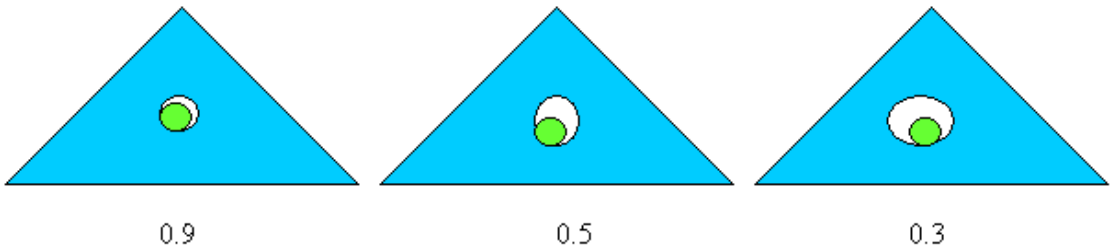

Figure 1. Ratio between fiber (1.2 mm OD) and hole diameters.

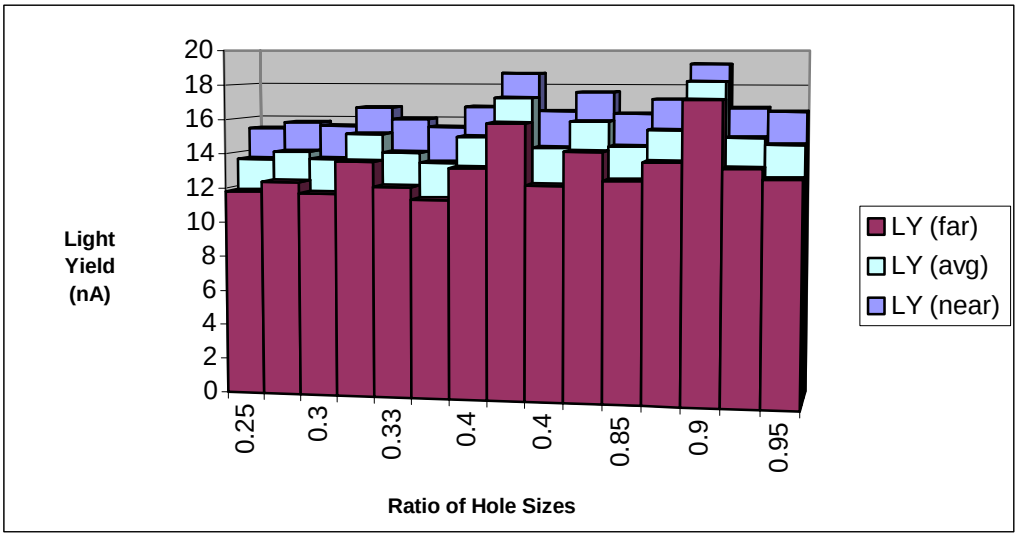

Figure 2. Light yield variations due to fiber/hole size ratios (no reflective end).

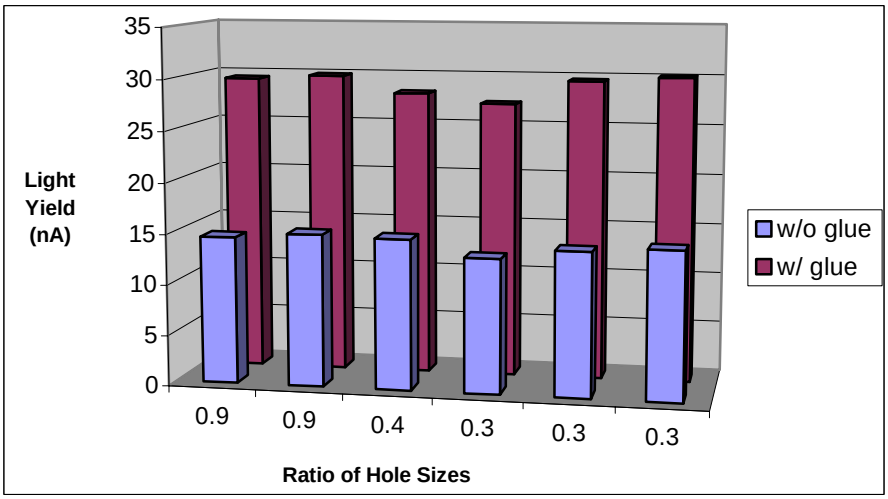

Figure 3. Average light yield with and without glue.

REFERENCES

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